

(12) **UK Patent Application** (19) **GB** (11) **2 267 487** (13) **A**
(43) Date of A publication 08.12.1993

(21) Application No 9211407.3

(22) Date of filing 29.05.1992

(71) Applicant
James Arthur Mason
PO Box 605, 6700 Browder Drive, Theodore,
Alabama 36582, United States of America

(72) Inventor
James Arthur Mason

(74) Agent and/or Address for Service
Murgitroyd & Company
373 Scotland Street, Glasgow, G5 8QA,
United Kingdom

(51) INT CL⁵
C02F 1/50 1/76

(52) UK CL (Edition L)
C1C CSCG C20X C200 C201 C254 C31X C323
C326 C41Y C412 C416

(56) Documents cited
GB 2239867 A GB 1487197 A GB 0828446 A
EP 0023040 A1 US 4959157 A US 4925645 A
US 4019983 A

(58) Field of search
UK CL (Edition K) C1C CACG CACH CRCG CRCH
CSCG CSCH CTCG CTCH
INT CL⁵ C02F 1/50 1/76

(54) **Method and apparatus for treating water and/or waste water**

(57) In a method and apparatus for treating and/or disinfecting water and/or wastewater chlorine, chlorine dioxide or precursors thereof are added and the contact vessel is sealed and held, optionally under greater than atmospheric pressure, for a detention time of no more than 5 minutes. Chlorine dioxide may be generated in aqueous solution by reaction of an organic hydroxy and or carboxylic acid with an alkali metal chlorite or alkaline earth metal chlorite.

1/1

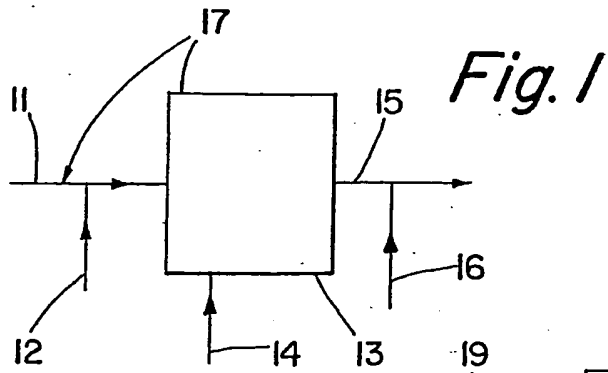


Fig. 1

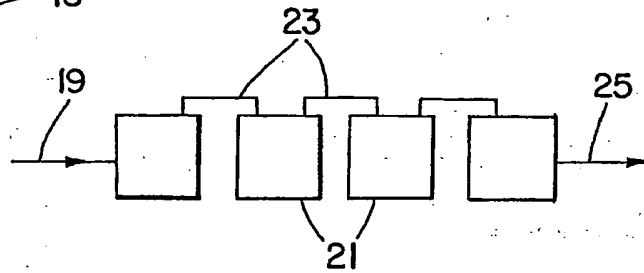


Fig. 2

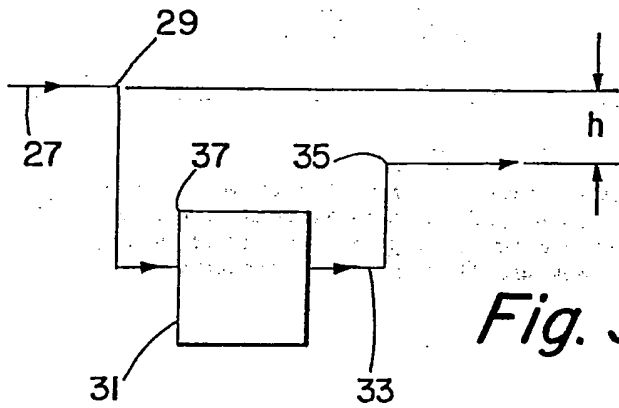


Fig. 3

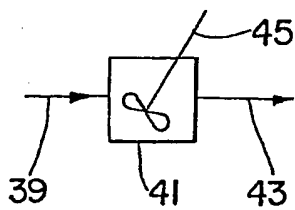


Fig. 4

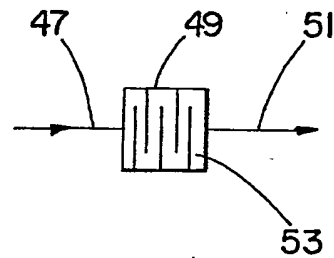


Fig. 5

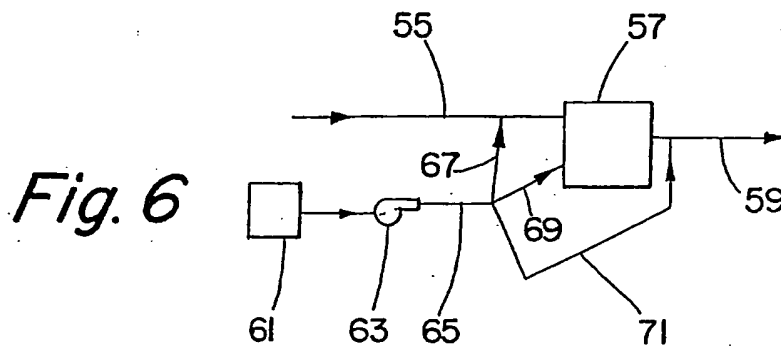


Fig. 6

DESCRIPTIONMethod and Apparatus for Treating Water and/or WastewaterTechnical Field

This invention generally relates to a method and apparatus for disinfecting water and/or wastewater with various chlorine containing compounds and/or chlorine, and for the production of chlorine containing compounds in concentrations suitable for use as an oxidizing and disinfecting agent in various industrial processes, more particularly, for treating and disinfecting water and/or wastewater. Other exemplary industrial processes where chlorine containing compounds may be used as an oxidizing and/or disinfecting agent include use as a whitening agent in the paper industry and as a water treatment chemical in the oil recovery industry; additionally, other industries where this invention may be useful include chicken and turkey processing, seafood processing including fish and shrimp, vegetable and fruit processing, for removing H_2S and sulfur from wastewater from the mining of silver, gold and other metals and precious metals, for both domestic and industrial wastewater, waters used in cooling towers and the like, for both domestic and industrial freshwater supply, beef and pork rendering, biomedical wastes and for removing H_2S from natural gas and crude oil wells.

Background Art

Methods and/or apparatuses for treating water and/or wastewater with chlorine dioxide produced from mixing organic acids and chlorites have been described in the prior art. Callera, in Canadian Patent No. 959,238, described a method and apparatus for producing chlorine dioxide in water. Tice, et al, in U.S. Patent No. 4,585,482, described a long-acting biocidal composition produced from a chlorine dioxide-liberating compound and an organic acid. Key, et al,

in U.S. Patent No. 4,310,425, described a system of producing chlorine dioxide for use as an anti-bacterial agent in oil field drilling fluid. Wentworth, in U.S. Patent No. 3,082,146, described a method for the treatment of water using a residual chlorous acid concentration by mixing therewith sodium chlorite and a peroxygen compound. Alliger, in U.S. Patent No. 4,084,747, described a germ-killing composition produced by contacting lactic acid with sodium chlorite in an aqueous media. Alcide Corporation, in International Application No. PCT/US 85/00470, described a process for disinfecting a substrate comprising contacting the substrate with a composition comprising a chlorine-dioxide liberating compound, such as sodium chlorite, with sufficient organic acid to lower the pH of the composition to less than about 7.

Mason, in U.S. Patent No. 4,968,501, described a novel method of using chlorous acid to remove sulfur dioxide from exhaust combustion gases. Mason, in U.S. Patent No. 4,801,353, described a method of bleaching wood pulp using an aqueous solution containing a salt of lactic acid and chlorous acid.

Mason, in U.S. Patent No. 4,925,645, described a process for producing a mixture containing chlorine dioxide which comprised several steps. Mason, in U.S. Patent No. 4,892,148, described a process of oil recovery including the steps of injecting flooding water into oil bearing subterranean formations which waters contained a mixture of a salt of lactic acid and chlorous acid.

The design, operation and control of chlorine contact chambers is thoroughly discussed in the text entitled "Wastewater Engineering Collection Treatment Disposal" by Metcalf and Eddy, Inc., McGraw-Hill Book Company, New York, New York, 1972, pages 470-478. This text discloses minimum retention times for chlorine contact chambers in the range of 15-30 minutes.

Typical chlorine contact chambers are constructed of either metal, such as steel, fiberglass, or concrete. They are normally open chambers and mixing may be provided by

hydraulic turbulence, mechanical means or having the chambers be compartmentalized.

However, none of the prior art cited above discloses the unique method and apparatus for treating and/or disinfecting water and/or wastewater as does the instant application.

Disclosure of Invention

One of the primary objectives and advantages of the present invention is that it allows for the formation of chlorine dioxide in an aqueous solution using bulk quantity reactants which allows for the production of a source of the chlorine dioxide off site rather than on-site at the particular industrial installation of importance. Off site production capability is important because it allows for a much safer generating process for chlorine dioxide whereby the risk of fire and explosion are minimized. It is anticipated that the solutions containing chlorine dioxide would be shipped to the plant site by, e.g., tank truck or railway tank car. Furthermore, the present invention allows for the mixing and formation of the chlorine dioxide in an aqueous solution involving bulk quantities and mixing ratios which are extremely simple and basic whereby more or less generally lesser-trained personnel can accomplish the production of the chlorine dioxide. This method allows for the delivery of a source of chlorine dioxide to a plant site by merely transporting an aqueous solution which is not now done because chlorine dioxide can not be safely transported and therefore is now generally generated on-site.

According to the invention there is provided a method of forming chlorine dioxide in an aqueous solution from the reaction of an organic hydroxy acid or carboxylic acid with a chlorite of an alkali metal or alkaline earth metal to yield a salt of the organic acid and chlorous acid. The reaction is carried out at a pH less than about 7 and at a temperature of less than about 120° F (48.9°C), generally in the range of approximately, 60° F (15.6°C) to 80° F (26.7°C) most preferably at about 62° F (16.7°C). The aqueous solution

containing chlorine dioxide formed from the aforementioned reaction is stable and can be safely transported by common carrier, e.g., tank truck or railway tank car, to the plant site. Lab tests have indicated that solutions made by mixing different organic acids, including lactic, citric, malic and tartaric acid, with sodium chlorite retained their concentrations within plus or minus 2% for at least 30 days.

The aforementioned reaction initiates a chain of reactions leading to the production of chlorine dioxide which is believed to be a central chemical agent of the present invention which makes it effective for the treatment and disinfection of water and/or wastewater. These further reactions, generally, involve the oxidation of various organic compounds or destruction of pathogens by either chlorous acid, chlorine dioxide or chlorine gas and will be further described by use of chemical equations in a following section of this specification.

Note that it may be feasible to substitute other alkali metal or alkaline earth metal chlorites in either liquid or solid form as a source of the chlorite referred to in this specification.

The aqueous solutions containing the chlorine compounds are then injected, mixed with or contacted with water and/or wastewater in some type of container, conduit, pipe, chamber, vessel or other enclosed space or cavity so that the chlorine compounds become thoroughly mixed with the water and/or wastewater for sufficient time so that treatment and disinfection of the water and/or wastewater occurs.

It may be possible to use chlorine, chlorine gas, ozone and/or chlorine dioxide made by any method and other disinfectants in conjunction with the present invention.

A key element of the present invention concerns the construction and operation of the container, chamber or vessel wherein the chlorine compounds are contacted with the water and/or wastewater. According to the present invention, the chamber or other enclosed space may be constructed and operated so that it provides an airtight or sealed chamber for a period of time effective or sufficient for the treatment and

disinfection to occur. Furthermore, the chamber may be constructed and operated so that the surface of the water and/or wastewater contained therein is under atmospheric pressure or a pressure greater than atmospheric pressure. It is believed that having the chamber be airtight or under a pressure greater than atmospheric is partially responsible for the unexpectedly rapid and high levels of treatment and/or disinfection resulting from the present invention, probably due to the fact that the individual molecules of the chlorine, chlorine dioxide and/or chlorine containing compounds are prevented and/or minimized from escaping from the water and/or wastewater, and held in close contact with the individual molecules of the water and/or wastewater. The increased pressures may also cause a greater amount of the chlorine, chlorine dioxide and/or chlorine containing compounds to dissolve in the water and/or wastewater.

It is believed that means for increasing the pressure on the surface of the water and/or wastewater in the contact chamber to greater than atmospheric would include (1) sizing and/or valving the exit or effluent outlet orifice for less flow than the entrance or influent orifice, (2) using some type of mechanical means such as a pump to put pressure on the contact chamber, and (3) elevating the effluent outlet line to an elevation above the contact chamber. It is believed that pressures in the range of about 1 to about 2 atmospheres are preferable to insure rapid and efficient treatment and yet be compatible with existing structures and construction techniques. Also, note that the pressure may vary due to the diurnal flow variation.

As previously mentioned, typical existing chlorine contact chambers in widespread use currently are constructed normally of steel or concrete and are open. Therefore, in order to retrofit existing structures according to the present invention the existing open chambers would have to be closed and a method of applying a pressure to the contents contained in the chamber would have to be adapted to the existing chamber. It is therefore critical that the present invention be compatible with existing chambers to make the retrofitting

of the existing chambers economically feasible. Since the chlorine contact chambers currently existing are frequently constructed of concrete, they cannot stand high internal pressures without leaking, cracking or possibly having a structural failure. Therefore, it is essential that the internal pressures be maintained in a relatively low pressure range.

The basic design and construction of chlorine contact chambers has been essentially unchanged for the last thirty to forty years. Open contact chambers are in widespread use throughout the nations of the developed world. The present invention is a marked improvement over the existing art and represents a major design, construction and operation improvement which can lead to major cost savings in the construction and operation of disinfection chambers used either by themselves or in conjunction with water and/or wastewater treatment systems.

It is believed that contact, detention or residence times in the contact chamber in the range of about 30 seconds to about 5 minutes are preferable. Note that these very short contact times are an unexpected result and advantage of the present invention. Longer detention times could be used, however the costs of constructing the contact chamber would increase.

The chlorine containing compounds produced and used by the method of the present invention are intended for use as a bactericide to inhibit the growth of bacteria and other microbes and pathogens found in water and/or wastewater in order to make it potable or to disinfect it as the case may be. It is also intended to remove color, odor, taste, iron, manganese and hydrogen sulfides that may be present in the water and/or wastewater. For example, such problems may be caused by algae, phenols and/or the presence of hydrogen sulfide. A particular advantage of the present invention is that the production of trihalomethane, other undesirable polychlorinated hydrocarbons such as dioxins, and chlorates and chlorites are minimized and/or eliminated.

Note it is believed that the organic acids mentioned in this specification may include lactic, citric, tartaric, malic, oxalic, glycolic and mandelic acids and/or other organic hydroxy acids and carboxylic acids.

Brief Description of Drawings

Fig. 1 is a schematic representation of one exemplary embodiment of the present invention.

Fig. 2 is a schematic representation of a second exemplary embodiment using the present invention.

Fig. 3 is a schematic representation of a third exemplary embodiment of the present invention drawn in non-scale elevation.

Fig. 4 is a schematic representation of one type of mixing chamber.

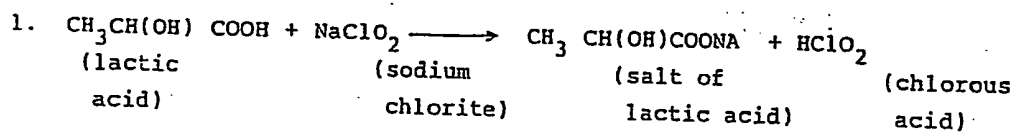
Fig. 5 is a schematic representation of a second type of mixing chamber using non-mechanical mixing means shown as a plan view.

Fig. 6 is a schematic representation of another exemplary embodiment of applicant's invention.

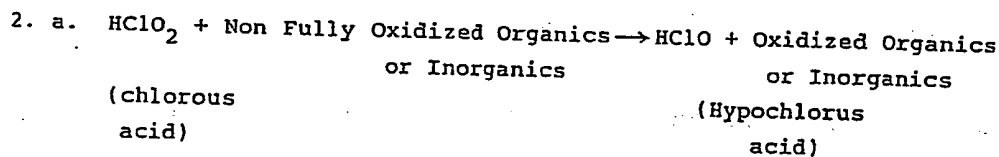
Best Mode for Carrying Out the Invention

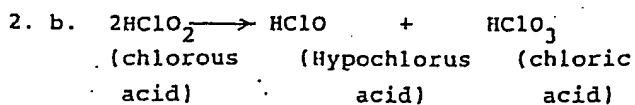
A more detailed description of the present invention follows in the form of chemical equations and examples.

The reactions utilized in the method of the present invention are believed to be as follows:



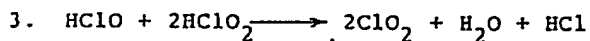
...It is believed that citric, malic, tartaric, glycolic, oxalic, and mandelic acid may be substituted for lactic acid.



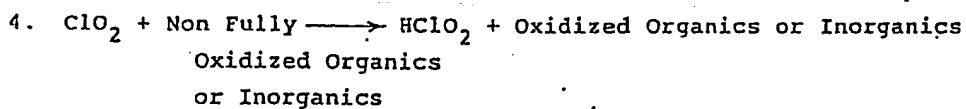


(This reaction occurs in absence of chloride ion)

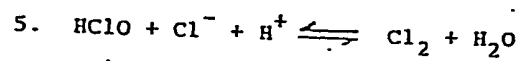
This reaction 2.b. is not desirable, but it will occur simultaneously with reaction 3., but not necessarily at the same rate.



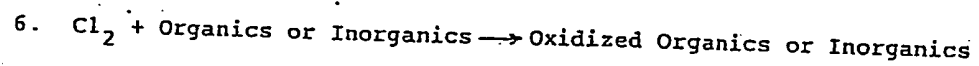
(This reaction occurs in absence of chloride ion)



Reaction 3. provides chloride ions, therefore the following reaction occurs:



The Chlorine reaction with organics or Inorganics is generally thought to be primarily an Oxidation as follows:-



The above reactions are carried out at a pH less than 7.

In practice, the reactants and reactions are produced by mixing bulk quantities of sodium chlorite and certain organic acids. Furthermore, it is believed that in the above reaction Number 1. that citric, malic, tartaric, glycolic, oxalic and mandelic acids may be substituted for the lactic acid to produce a salt of the organic acid and chlorous acid in an aqueous solution.

The above reaction Number 1. is accomplished by mixing the reactants together at atmospheric pressure in an aqueous solution with the water temperature being approximately 62° F (16.7°C) being in the range of about 60° F (15.6°C) to about 80° F (26.7°C). The higher water temperatures nearing about 80° F (26.7°C) can be used if necessary to increase the reaction speed. Higher water temperatures may be feasible.

It may be feasible to use chlorine, ozone, chlorine gas and/or chlorine dioxide made by any method in conjunction with the present invention.

The aqueous solutions of the chlorine containing compounds produced by the aforementioned reactions may be prepared according to the following steps: (a) a first solution is formed by adding an organic acid into the water in a reaction vessel; (b) thereafter the first solution is mixed by stirring; (c) a second solution is then formed by introducing sodium chlorite into the first solution, this addition being followed by additional mixing; (d) the second solution is then stirred and mixed. Note that it is believed that several different organic acids may be used to produce the aqueous solutions for the production of the chlorine containing compounds. Also note that the chlorine containing compounds formed by these reaction steps is known to be very stable as aforementioned. It is believed that the aforementioned steps for producing the chlorine containing compounds are critical in order to assure that the mixtures have all of the properties of the present invention.

It should be noted that the aforementioned reactions result in a mixture of species of compounds which is believed to include chlorous acid, chloric acid, chlorine dioxide or

chlorine; it is further believed that the powerful oxidation and/or disinfection nature and characteristics of the present invention is due to a mixture of these compounds acting either jointly or singularly, or, acting as a mixture of these chemical substances.

The aqueous solutions containing the chlorine compounds are then injected, mixed with or contacted with water and/or wastewater in some type of container, conduit, pipe, chamber, vessel or other enclosed space or cavity so that the chlorine compounds become thoroughly mixed with the water and/or wastewater for sufficient time so that treatment and disinfection of the water and/or wastewater occurs.

It is expected that the aqueous solution of the chlorine containing substances would normally be injected following the typical primary, secondary or tertiary water and/or wastewater treatment system, i.e., where final chlorination is normally accomplished. However, other points of injection are possible also, e.g., prior to primary sedimentation.

The above reactions produces aqueous solutions containing very high concentrations of chlorine dioxide ranging from generally about 4,000 ppm to about 80,000 ppm. Furthermore, the chlorine dioxide produced by the present invention appears to have more oxidizing and pathogen destroying power on a per unit basis than chlorine dioxide produced by other methods. Mixtures of about 4,000 ppm to about 6,000 ppm chlorine dioxide commonly occur in these solutions.

Turning to Fig.1, one exemplary schematic embodiment for using the present invention to treat or disinfect water and/or wastewater is shown. At 11, the influent line or inlet line to the contact chamber is shown with the contact chamber, or mixing vessel 13.

The effluent discharge line or outlet line is shown at 15. Note that the pressure of the contents of the mixing vessel may be greater than about one atmosphere and that the detention time is about 30 seconds to about 5 minutes. However, the present invention would function, i.e., oxidize or disinfect, if the detention times were increased, e.g., in

the range of about 5 minutes to about 15 minutes or longer. However, the costs of construction would increase.

It is believed that means for increasing the pressure on the surface of the water and/or wastewater in the contact chamber to a pressure greater than atmospheric could include sizing and/or valving the exit or effluent outlet line, 15, so that it could carry less flow than the entrance or influent line, 11. Additionally, some type of mechanical means, e.g., a pump, could be used at, 17, to put pressure on the influent line or the contact chamber. Alternatively, the elevation of the effluent line with respect to the mixing vessel could be designed to cause a greater than atmospheric pressure to be exerted on the liquids contained therein. Note that the aqueous solution could alternatively be injected into the influent line, 11, either through the single line 12 or into the chamber, 13, through the single line 14; or, it might be possible to inject the aqueous solution through line 16 into the effluent line 15, if the effluent line were long enough to provide adequate detention time and acceptable mixing.

Turning to Fig. 2, a second exemplary schematic embodiment for using the present invention to treat or disinfect water and/or wastewater is shown. Fig. 2, is merely a series of more than one contact chamber using the teachings of the present invention. At 19, the influent line to the series of chambers is shown with greater than one chamber being shown at 21. Interconnecting piping between the chamber is shown at 23. The effluent discharge line from the chambers is shown at 25. The construction and operation of the embodiment shown in Fig. 2, is similar to the embodiment shown in Fig. 1.

Turning to Figs 3, a third exemplary schematic embodiment of the present invention to treat or disinfect water and/or wastewater is shown. At 27, the influent line to the contact chamber is shown with the chamber, 31. The effluent discharge line is shown at 33. The embodiment of Figure 3 has the influent line and effluent line designed to be constructed at certain elevations with respect to the contact chamber, 31, so that a pressure greater than atmospheric occurs on the

contents of the contact chamber, 31. By example, the elevation of the influent line, 27, at the point, 29, is greater than the elevation of the effluent line, 33, at the point 35; and, the elevation of the effluent line 33, at the point 35 is greater than the elevation of the contact chamber, 31, at the point 37. In other words, if the elevation at 29 is h_1 ; and, the elevation at 35 is h_2 ; and, elevation at 37 is h_3 , then, h_1 greater than h_2 greater than h_3 . It follows, according to the laws of physics, that the pressure on the liquid in the contact chamber, 31, would be greater than atmospheric pressure. Note that the differential elevation of the influent line, 27, over the elevation of the effluent line, 33, must be great enough so that a proper hydraulic gradient is maintained through the contact chamber in order that flow will occur from the direction of the influent line toward the effluent line because of hydraulic friction losses in the piping and appurtenances, i.e., the chamber must be taken into consideration in the design. However, other possible configurations exist, e.g., h_1 greater than $h_2 = h_3$ or h_1 greater than h_3 greater than h_2 , which would also cause the pressure on the liquid in the contact chamber to be greater than atmospheric. As used herein, the term elevation is used to mean the height to which something is elevated.

Normally, the aqueous solution containing the chlorine containing substances would be injected into the mixing vessel or contact chamber, i.e., in Figs. 1, 2, 3, these would be shown at 13, 21 and 31, respectively. Alternatively, the aqueous solutions of the chlorine containing compounds could be injected into the influent lines respectively in Figures 1, 2 and 3 prior to the contact chamber itself. Furthermore, mixing by hydraulic turbulence at or near the point of addition of the chlorine containing compounds to the water and/or wastewater is recommended if mechanical mixing is not used. Furthermore, it is possible to achieve mixing in the contact chamber by compartmentalizing the chlorine contact chamber.

Turning to Figure 4, there is shown another type of contact chamber having mechanical mixing means. The influent

line, 39, is shown with the contact chamber, 41, and the effluent line, 43. The mechanical mixing means is shown at 45.

Turning to Figure 5, there is shown another type of contact chamber having a certain type of compartmentalization. The influent line is shown at 47, with the contact chamber being at 49. The effluent line is shown at 51. The contact chamber is shown having compartmentalized partitions, 53, constructed in it so as to route the flow of water and/or wastewater through it in such a manner as to assure mixing.

Turning to Fig. 6, there is shown a schematic exemplary embodiment of applicant's invention in somewhat of an operative connection. There is shown an influent line, 55, to a contact chamber, 57, having an effluent line, 59. Additionally, there is shown a vessel, 61, which contains an aqueous solution of the chlorine containing compounds, connected to an influent pump, 63, through the connecting line, 65, connecting thereto alternatively to the influent line, 55, through the line 67 or alternatively, to the contact chamber, 57, through line 69. As stated previously, it would be possible to inject the aqueous solution through line 67, into the influent line, 55, or alternatively directly into the contact chamber, 57, through the line, 69. Also, it might be possible to alternatively inject the aqueous solution through line 71 into the effluent line, 59, if the effluent line were long enough to provide adequate detention time and provided acceptable mixing.

The actual construction, application and/or use of applicant's invention at the plant level could very well utilize a combination of the examples, Figures or parts thereof presented herein.

It should be understood that the teachings of this specification are given by way of example, illustration and explanation thereof and not by way of limitation because many changes in the invention may be effected without departing in anyway from the scope and spirit of this invention as disclosed in the specification, drawings and claims contained herein.

Claims

I Claim:

1. In a process for treating and disinfecting water and/or wastewater which includes introducing an aqueous solution into a chamber containing water and/or wastewater, the improvement comprising the steps of:
 - (a) introducing into the chamber containing said water and/or wastewater an aqueous solution prepared by mixing at a pH less than 7 and at a temperature less than about 48.9°C (1) an organic hydroxy acid or carboxylic acid and (2) an alkali metal or alkaline earth metal chlorite;
 - (b) sealing the contents of said chamber from the atmosphere; and
 - (c) detaining the contents of said chamber for a period of time of no more than 5 minutes whereby substantially all bacteria, microbes and other pathogenic organisms are destroyed in said water and/or wastewater.
2. The process of claim 1 wherein the contents of said chamber is under greater than atmospheric pressure.
3. The process of claim 2, wherein the water temperature of said aqueous solution is in the range of about 15.6°C to about 26.7°C.
4. The process of claim 2, wherein an influent line of said chamber is positioned above an effluent line of said chamber; and said effluent line of said chamber is positioned above a top of said chamber; and wherein the liquid contents of said chamber are thereby under greater than atmospheric pressure.
5. In a process for treating and disinfecting water and/or wastewater which includes introducing an aqueous solution into a chamber containing water and/or wastewater, the improvement comprising the steps of:

- (a) introducing into the chamber containing said water and/or wastewater an aqueous solution prepared by mixing at a pH less than 7 and at a temperature less than about 48.9°C (1) lactic acid and (2) sodium chlorite; (b) sealing the contents of said chamber from the atmosphere; and (c) detaining the contents of said chamber for a period of time of no more than 5 minutes whereby substantially all bacteria, microbes and other pathogenic organisms are destroyed in said water and/or wastewater.
6. The process of claim 5, wherein the contents of said chamber is under greater than atmospheric pressure.
 7. The process of claim 6, wherein the water temperature of said aqueous solution is in the range of about 15.6°C to about 26.7°C.
 8. The process of claim 1 or 5, wherein the organic acid is citric acid.
 9. The process of claim 1 or 5, wherein the organic acid is malic acid.
 10. The process of claim 1 or 5, wherein the organic acid is tartaric acid.
 11. The process of claim 1 or 5, wherein the organic acid is glycolic acid.
 12. The process of claim 1 or 5, wherein the organic acid is mandelic acid.
 13. The process of claim 1 or 5, wherein the organic acid is oxalic acid.
 14. The process of claim 6, wherein an influent line of said chamber is positioned above an effluent line of said chamber; and said effluent line of said chamber is positioned above a top of said chamber; and wherein the liquid contents of said chamber are thereby under greater than atmospheric pressure.
 15. An apparatus for treating and disinfecting water and/or wastewater comprising:
 - (a) a chamber;
 - (b) said chamber having an inlet line and an outlet line for the water and/or wastewater;

- (c) means containing an aqueous solution of (1) an organic hydroxy acid or carboxylic acid and (2) an alkali metal or alkaline earth metal chlorite;
 - (d) means for providing said aqueous solution to said chamber;
 - (e) said chamber being sized to provide a detention time of no more than 5 minutes for the water and/or wastewater; and
 - (f) said chamber being sealed from the atmosphere said apparatus thereby effective to destroy substantially all bacteria, microbes and other pathogenic organisms in said water and/or wastewater;
- 16. The apparatus of claim 15, further comprising said chamber having means for providing a pressure of greater than 1 atmosphere on the contents of said chamber.
 - 17. The apparatus of claim 16, wherein: said means for providing a pressure of greater than 1 atmosphere on the contents of the chamber further comprises (a) having the elevation of the inlet line of said chamber be above the elevation of the outlet line of said chamber; (b) having the elevation of the outlet line of said chamber be above the elevation of the top of said chamber; and (c) whereby the liquid contents of said chamber are under greater than atmospheric pressure.
 - 18. The process of claim 1, wherein the contents of said chamber is under a pressure ranging from about one atmospheres to about two atmospheres.
 - 19. The process of claim 5, wherein the contents of said chamber is under a pressure ranging from about one atmosphere to about two atmospheres.
 - 20. The apparatus of claim 15 wherein the contents of said chamber is under pressure ranging from about one atmosphere to about two atmospheres.
 - 21. An apparatus for treating and disinfecting water and/or wastewater comprising:

- (a) a chamber;
 - (b) said chamber having an inlet line and an outlet line for the water and/or wastewater;
 - (c) means containing an aqueous solution of chlorine containing substances;
 - (d) means for providing said aqueous solution to said chamber;
 - (e) said chamber being sized to provide a detention time of no more than 5 minutes for the water and/or wastewater; and
 - (f) said chamber being sealed from the atmosphere said apparatus thereby effective to destroy substantially all bacteria, microbes, and other pathogenic organisms in said water and/or wastewater.
22. The apparatus of claim 21, further comprising said chamber having means for providing a pressure of greater than 1 atmosphere on the contents of said chamber.
23. The apparatus of claim 22, wherein: said means for providing a pressure of greater than 1 atmosphere on the contents of the chamber further comprises (a) having the elevation of the inlet line of said chamber be above the elevation of the outlet line of said chamber; (b) having the elevation of the outlet line of said chamber be above the elevation of the top of said chamber; and (c) whereby the liquid contents of said chamber are under greater than atmospheric pressure.
24. The apparatus of claim 21, wherein the contents of said chamber is under pressure ranging from about one atmosphere to about two atmospheres.
25. The apparatus of claim 21, wherein said chamber is sized to provide a detention time of from about 5 to about 15 minutes for the water and/or wastewater.
26. In a process for treating and disinfecting water and/or wastewater which includes introducing an aqueous solution into a chamber containing water

and/or wastewater, the improvement comprising the steps of:

(a) introducing into the chamber containing said water and/or wastewater a disinfectant selected from the group consisting of chlorine; chlorine dioxide and a chlorine containing substance;

(b) sealing the contents of said chamber from the atmosphere; and

(c) detaining the contents of said chamber for a period of time of no more than 5 minutes whereby substantially all bacteria, microbes and other pathogenic organisms are destroyed in said water and/or wastewater.

27. The process of claim 26, further comprising pressurizing the chamber to a pressure above atmospheric pressure.
28. The process of Claim 26, wherein the contents of said chamber is under pressure ranging from about one atmosphere to about two at atmospheres.
29. The process of Claim 1 or 5 or 26, further comprising detaining the contents of said chamber for a period of time of from about 5 to about 15 minutes whereby substantially all bacteria, microbes and other pathogenic organisms are destroyed in said water and/or wastewater.
30. The apparatus of Claim 15, wherein the organic acid is lactic acid.
31. The apparatus of Claim 15, wherein the organic acid is citric acid.
32. The apparatus of Claim 15, wherein the organic acid is malic acid.
33. The apparatus of Claim 15, wherein the organic acid is tartaric acid.
34. The apparatus of Claim 15, wherein the organic acid is glycolic acid.
35. The apparatus of Claim 15, wherein the organic acid is mandelic acid.

36. The apparatus of Claim 15, wherein the organic acid is oxalic acid.
37. The process of Claim 27, wherein an influent line of said chamber is positioned above an effluent line of said chamber; and said effluent line of said chamber is positioned above a top of said chamber; and wherein the liquid contents of said chamber are thereby under greater than atmospheric pressure.

Patents Act 1977
Examiner's report to the Comptroller under
Section 17 (The Search Report)

-22-

Application number

GB 9211407.3

Relevant Technical fields

(i) UK CI (Edition K) C1C (CAGG, CACH, CRCG, CRCH,
CSCG, CSCH, CTCG, CTCH)

(ii) Int CI (Edition 5) C02F 1/50; C02F 1/76

Search Examiner

G M BRIDGES

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

24 AUGUST 1992

Documents considered relevant following a search in respect of claims 1 TO 37

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
Y	GB 2239867 A (J A MASON) whole document	1,3,5,7- 13, 15, 30-36
X	GB 1487197 A (COCA-COLA CO) see eg page 2 line 92 - page 3 line 96	21,22,26, 27 1,2,5,6, 15,16
Y		
X	GB 828446 A (PROCEDES INDUSTRIELS ET CHARBONS ACTIFS) - see eg page 2 lines 60-114	21,22,24, 26-28 1,2,5,6, 15,16, 18-20
Y		
X	EP 0023040 A1 (HOELZLE & CHELUIS KG) see description with respect to Figure 4	21, 26 1,5,15
Y		
X	US 4959157 A (DOW CHEMICAL CO) see abstract and column 3 lines 26 - column 4 line 27	21,25,26, 29 1,5,15
Y		
Y	US 4925645 A (J A MASON) see eg column 1 line 59 - column 2 line 6; column 2 lines 26-29; column 5 lines 24-28	1,3,5,7- 13,15, 30-36

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

Patents Act 1977
Examiner's report to the Comptroller under
Section 17 (The Search Report)

-24-

Application number

GB 9211407.3

Relevant Technical fields

(i) UK Cl (Edition) Contd. from page 1

(ii) Int Cl (Edition)

Databases (see over)

(i) UK Patent Office

(ii)

Search Examiner

G M BRIDGES

Date of Search

24 AUGUST 1992

Documents considered relevant following a search in respect of claims

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X Y	US 4019983 A (HOUDALLE INDUSTRIES) see eg column 11 line 22 - column 16 line 56	21,22,24, 25-29 1,2,5,6, 15,16,18, 19

SF2(p)

SJJ - doc99\fil000409

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

THIS PAGE BLANK (USPTO)

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☒ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☒ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

THIS PAGE BLANK (USPTO)